IMPLEMENTATION OF A SMART GRID ELECTRICAL DISTRIBUTION TRAINING NETWORK

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Abstract - The objective of the present study was the implementation of an electrical distribution network or SMART GRID, with the help of the SCADA system, real-time control and monitoring was carried out, which contains synoptics that allowed the operation and characteristics implemented to the Educational network in the back of the laboratories of the Electrical Maintenance Engineering (CIMANELE). Subsequently, the design of the electric network was carried out in medium and low voltage, which allowed to carry out different practices being these: The connection and disconnection of the network and the correction of the power factor, the same that can be done manually or automatically. Initially the study presented theories regarding the distribution network with SMART GRID, its parts, advantages and disadvantages for its implementation, as well as components and control parameters of the system that applies the intelligent network. Following this, it was presented the SCADA system that performs the management and control of processes that can be local or remote systems of the electric network, through the help of the programs MOVICON 11.5 and TIA Portal V14, the same ones that when working together perform The control and monitoring of devices that are installed in the network. In addition, the RS-485 communication network and the use of the Modbus TCP / IP protocol enabled the acquisition of real-time data between the S7-1200 PLC and the Controller MASTER Control network analyzer VAR, consequently, detailed programming and control In the SCADA system. A graphical interface, programmed in the MOVICON 11.5 software, was obtained with a menu containing the control of inductive loads, resistive loads, capacitive loads, breaker, as well as data acquisition of the electrical parameters. And finally, the study presented a series of figures and annexes that complemented the project, operation and conclusions.

INTRODUCTION

In the city of Ibarra between 1912 and 1913 electric power was not available for citizens. The Municipality of Ibarra establishes an ordinance that obliged the owners of urban buildings to place a lighthouse in each of their houses that illuminated from 7 to 9 at night that is how a very rudimentary first delivery system began. For 1914, the Council of the Municipality of Ibarra signed the first contract for the provision of electricity in order to counteract the problems of childbirth in the city, and since 1915 the city has been illuminated thanks to the first hydroelectric power station called Business Hydroelectric San Miguel, Built next to the Tahuando River, and that until today has gone through different processes of electrical supply.

Since the last decade governments have taken importance of electric power in Ecuador, with the change of the Energy Matrix. The electrical industry is beginning to focus on the use and implementation of new technologies that more efficiently use the generation, transmission and distribution of electricity. In the past, electricity networks suffered from inefficiencies that cost companies a lot, and with the new engineering it is possible to automate, design and control networks so that they do not generate more interruptions in the electrical system, using so-called smart grids. In addition, the system that seeks to be implemented in Ecuador is the country's own electricity generation, becoming energy exporters and contributing to Ecuador's own electricity supply.

A. PROBLEM APPROACH

According to (Comes, 2012) in the electrical distribution system there is a large number of components that make it more difficult to monitor and control interruptions in the system. An upgrade or expansion of the size of the network can cause a reconfiguration that falls on overloads, parallel feed or unwanted ties, meshes. Interruptions in the distribution system are greater than in transmission and subtransmission due to outdated power grids. The companies supplying the electricity grid are limited to the replacement of the electric service, but not to the maintenance and monitoring of the operation of the system by the extensive circuits.

In distribution grid systems the location and monitoring is difficult due to the large number of circuits in the generation, transmission and distribution of electric power. CIMANELE, because it does not have an electrical network laboratory, does not contribute to the development of students in this area. The nonexistent intelligent network at the industrial level, precludes the ability to perform tests, maintenance, simulations in different parts of the electrical network.

B. GENERAL OBJECTIVE

Implement a network of training of electrical distribution controlled and monitored by a SMART GRID system to complement the theoretical and practical knowledge of CIMANELE students.

C. SPECIFIC OBJECTIVES

1. Analyze Smart grid electrical systems, SMART GRID to understand their operation, characteristics, standards and thus determine the most suitable for this project.
2. Design and implement a distribution network of training for medium and low voltage, with elements of automation and correction of power factor.
3. Develop and implement a SMART GRID system for the monitoring and control of the distribution grid.
4. Develop a laboratory practice protocol for the distribution grid.

D. PROGRAMMING

Programming of RS-485 communication, control and monitoring. It is presented in the flow diagram, which details the segments of the programming that allows the acquisition of data in real time, which can be visualized the fp of the elements that need to be corrected. The programming was done in the program TIA Portal V14 as well as its graphic interface in the program MOVICON 11.5

In Figure 1, the flowchart describing the operation of the programming is shown.

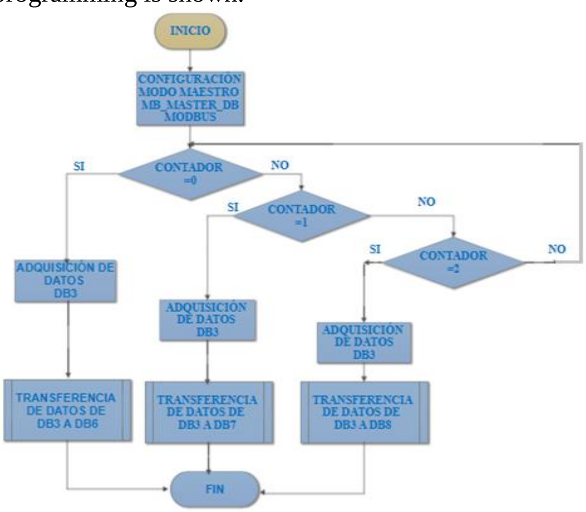

Figure 1. Flow Diagram

E. MAIN SYNOPTICS FOR CONROL AND MONITORING THE DISTRIBUTION NETWORK

Figure 2 shows the menu that allows to control each of the elements used and installed in the smart distribution network.

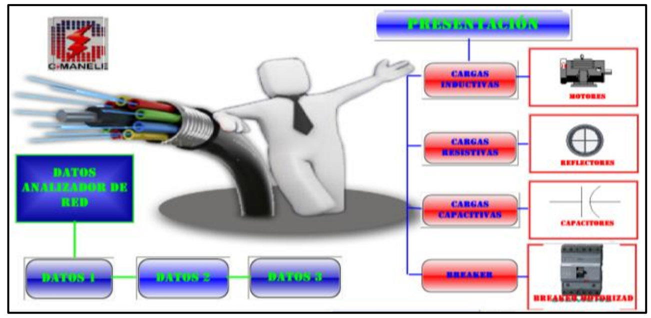

Figure 2. Start screen. MOVICON 11.5

INDUCTIVE LOADS screen: This screen shows the diagram and diagram of control and force of the motors, in this menu you can find several icons of both (ON) and (OFF), as well as the icon of START which if it is Pressed to return to the start menu. From this screen, the motors on and off will be controlled, as shown in Figure 3.

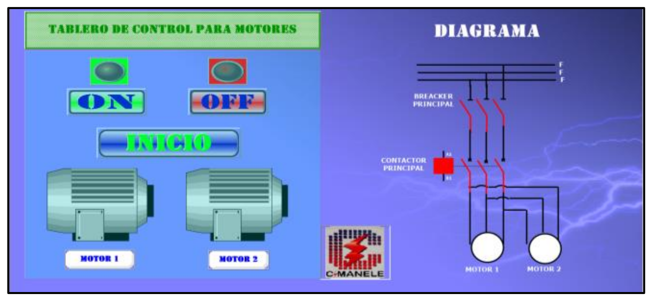

Figure 3. Control of Engines. MOVICON 11.5

RESISTIVE LOADS screen: This screen contains the schematic and control diagram and force of reflectors, here in this menu you can find several icons of both (ON) and (OFF), as well as the icon of HOME which if pressed you will be returned to the start menu. From this screen you will control the turning on and off of reflectors, as shown in Figure 4.

Figure 4. Control of reflectors. MOVICON 11.5

CAPACITIVE LOADS screen: This screen shows the diagram and diagram of capacitor banks that are: bank1 bank2, bank3, here in this menu you can find several icons of both (ON) and (OFF) of each bank of capacitors , As well as the HOME icon which if pressed will be returned to the start menu, as shown in Figure 5.

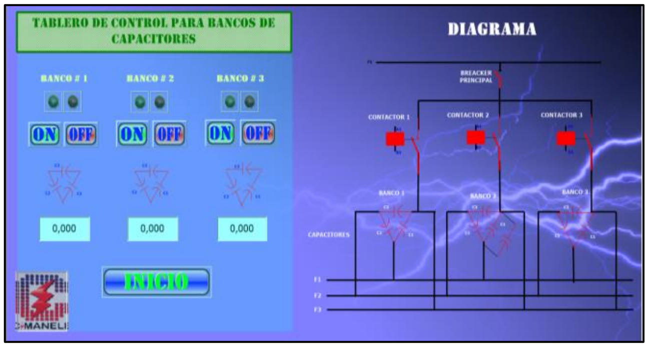

Figure 5. Control of capacitor banks. MOVICON 11.5

BREAKER: Figure 6 shows the screen that shows the schematic and control diagram of the intelligent network, here in this menu you can find several icons of both (ON) and (OFF), as well as the icon of START the Which if pressed will return to the start menu. From this screen you will control the connection and disconnection of the distribution network.

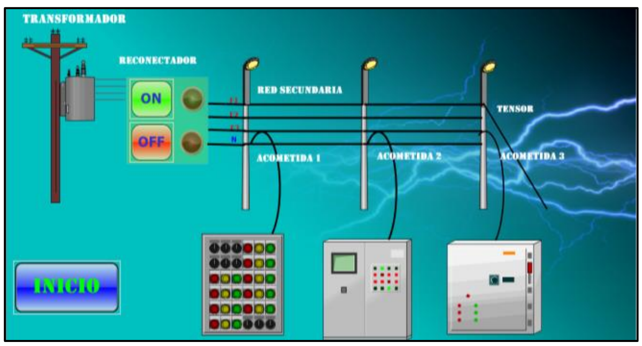

Figure 6. Breaker control ON / OFF. MOVICON 11.5

DIAGRAM Screen: Figure 7 shows the layout of the distribution network. There is also an START icon which if pressed will allow you to return to the start menu.

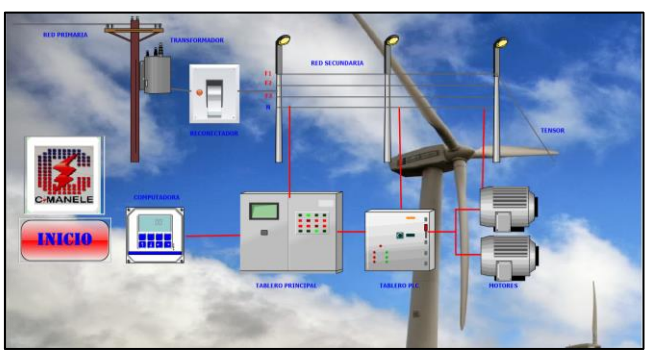

Figure 7. Distribution network scheme. MOVICON 11.5

DATA Display 1: Shows the parameters that are acquired from the network analyzer, as well as the voltages, currents, power factor, active powers, apparent powers, active powers, reactive powers, as well as the HOME icon which if pressed will return to the start menu, as shown in Figure 8.

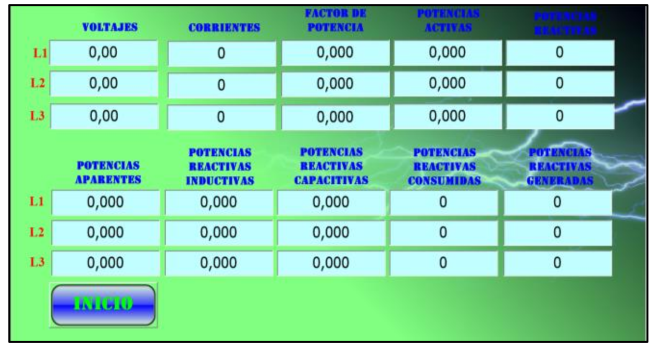

Figure 8. Data 1, Network analyzer. MOVICON 11.5

DATA screen 2: Shows the values of the elements connected to the smart grid, the values shown on this screen are three-phase parameters, the HOME icon which, if pressed, will return to the start menu. From this screen we can observe real-time data of the three-phase system, voltages between phases and cosine of the angle, as shown in Figure 9.

Figure 9. Data 2, Network analyzer. MOVICON 11.5

DATA screen 3: Displays the data that the network analyzer delivers, as well as the START icon which if pressed will return to the start menu. From this screen, the values of the elements of the smart grid are displayed. Here you can see the real-time values of active energy, inductive energy, capacitive energy, apparent energy, frequency and temperature, as shown in Figure 10.

Figure 10. Data 3, Network analyzer. MOVICON 11.5

F. PRACTICE AND RESULTS

In Figure 11, the motorized breaker is off, so that the network is de-energized.

Figure 11: Breaker Motorized in OFF state

In Figure 12, change the position, which shows the motorized breaker on, indicates that the network is energized.

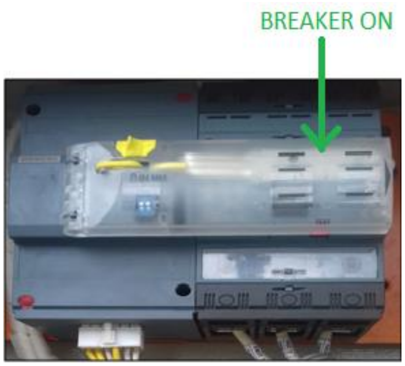

Figure 12. Breaker Motorized in ON state

G. RESULTS OF POWER FACTOR CORRECTION

The results of the Power Factor correction are presented in the following Figures.

In Figure 13, the control for turning on and off of bank 1, bank 2 and bank 3 is displayed and shows the power factor values. These FP values are displayed in normal state in the values of the network are observed without activating any capacitor bank.

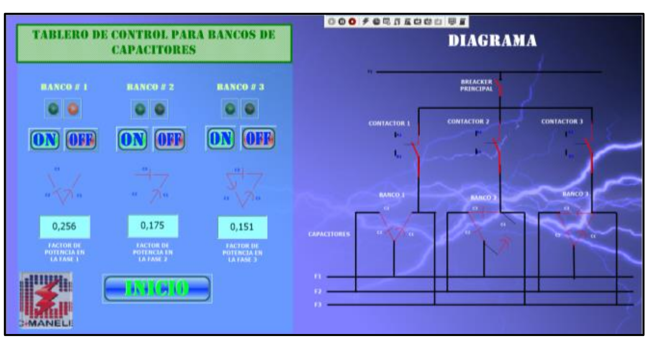

Figure 15. Power Factor

In Figure 14, the first capacitor bank is displayed activated, therefore the Fp has been modified, from 0.256 to 0.325 in one phase which allows to reach an Fp suitable for its operation.

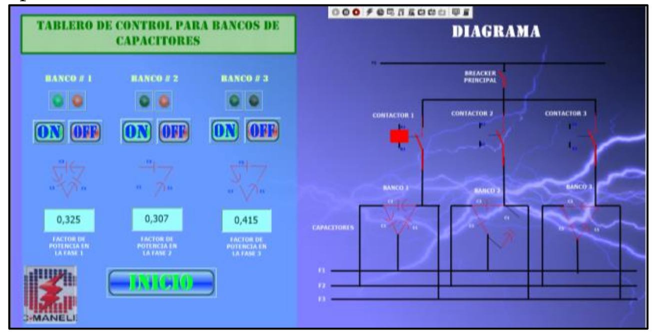

Figure 14: Power Factor, Bank 1 On

In Figure 15, it is shown that the first and second capacitor banks have been activated, so that the Fp has been modified and reaches from 0.325 to 0.913.

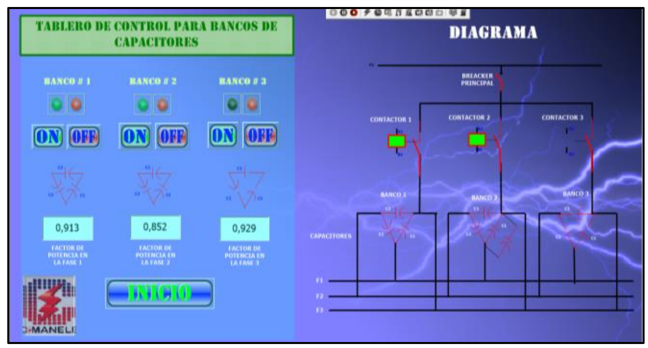

Figure 15. Power Factor, Bench 2 Power

In Figure 16, it is shown that the three capacitor banks have been activated, so that the Fp has been modified and passes from FP 0.913 inductive to 0.314 FP capacitive, the objective is that this data is between the range of 0.87 and 0.92 inductive.

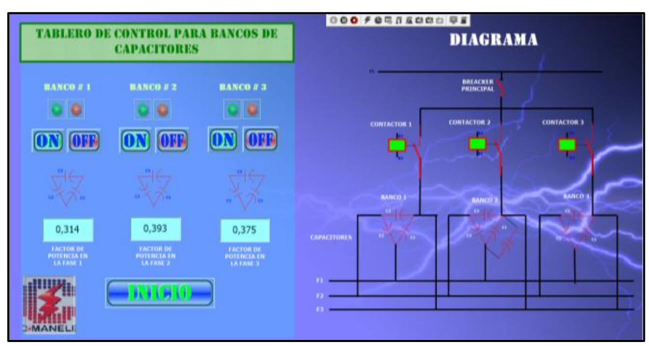

Figure 16. Power Factor, Bench 3 On

In Figure 17, the main network parameters and the elements connected to the network are displayed. Here you can monitor each of the parameters, as well as verify the changes of the aforementioned.

Figure 17. Data 3 Main Parameters of the Distribution Network

Figure 18 shows the three-phase parameters of the network and elements connected to it. Here, each of the three-phase parameters is monitored and the values of the above-mentioned values are checked.

Figure 18. Data 2 Three-Phase Parameters

In Figure 19, the parameters of the electrical energy are shown. Here you can observe each of the parameters, as well as verify the changes.

Figure 19. Data 3 Power Parameters

H. CONCLUSIONES Y RECOMENDACIONES

CONCLUSIONS

- With this project it is easy to understand the benefits of intelligent distribution networks in the different electric fields, so technologies have more advantages than disadvantages, which can be said that smart grids is the way to the future, ie Which work together and coordinate to control, monitor and deliver quality energy to consumers. With all these improvements being made in the electric field you can go very far, probably up to a level of realizing intelligent houses with practically 100% efficiency, in such a way that allow to help and improve the situation of the environment.
- Public and private companies to implement a smart grid will have more control over the energy process, which for energy companies is a new strategy smart networks or "SMART GRID", which will be a better solution for better Taking advantage of the distribution of energy to consumers, so that companies obtain more benefits associated with the reduction of energy losses, so with the introduction of smart grids can predict what will be the next step in the electric field.
- The smart grid brings benefits and design challenges to the utility, private and associated technology companies. It is anticipated that smarter grid technologies will be adopted by companies in the future, allowing an efficient, economical, reliable, and resilient distribution system. With the penetration of renewable energy sources, such as photovoltaic modules, photovoltaic energy, continue to grow and reach a significant level, so new technologies are needed to cope with the uncertainties that arise in the future. Smart vehicles, smart homes, smart buildings will play an important role in managing the energy of the future.
- The optimization of the operations with a network of reliability, efficiency and with the smaller limitations and losses generate benefits for the industry as for the client. In addition, the adoption of new technologies oriented to automation allows to build a more advanced infrastructure. Therefore, the help of these intelligent devices allow to be connected with consumers in real time, generate a shift to the conservation and good use of energy demand. What results in benefits that help reduce costs in public services, being a greater incentive for investment.
- Intelligent metering reduces the long-term cost utility, so that when you take the meter reading you can have faster and more efficient billing estimates. This can constitute a better development of infrastructure and benefit for society in general, associated with the optimization of resources through the use of renewable energy.

RECOMMENDATIONS

- For governments it is suggested to start with small scale tests of the implementation of SMART GRID, where technology and investment management can be evaluated, which helps to formalize an efficient environment with an intelligent network.
- As for the industry, the exploration of the automated communication and distribution networks allows a better understanding of the security that will provide the continuous operation in the electrical systems.

Such may be the case for a new orientation towards projects of storage and generation of renewable energy that drives the electric motors industry. In addition to enabling new products and services to market, improving reliability and optimization of resources.

- Exploring and implementing new technologies would increase the competitiveness of the market, which will promote the development and progress of the country taking into account the commitment to the environment using renewable energy.
- Develop a very detailed research on costs for the implementation of SMART GRID, which allows to develop implementation projects that are feasible and successful.
- The operation of the practice is important to check, load and compile the programming in the Siemens S7-1200 PLC, as well as the respective module connections and RS-485 communication cable. Following this, the configuration of the slave with which the data acquisition is being carried out must be checked, in which the speed, parity and the number with which the slave is identified are shown.

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